anne bindoff CONSULTANCY

Reg no: 2014/011805/07

MOTIVATION IN SUPPORT OF THE APPLICATION TO EXCLUDE EFFLUENT TREATMENT PLANT SLUDGE WASTE FROM THE DEFINITION OF WASTE

for

ILLOVO SUGAR (SOUTH AFRICA) (PTY) LTD SEZELA SUGAR MILL & DOWNSTREAM PRODUCTION PLANT

by

Anne Bindoff

Anne Bindoff Consultancy.

September 2023

Address: PO Box 1794,
Umhlanga Rocks, 4320.

Cell: (083) 655-1132
Mail: annebc@cykelbin.co.za.
Web: www.etremkards.co.za.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

DETAILS OF THE SPECIALIST

Name of Company: Anne Bindoff Consultancy.
Name: Anne Bindoff: Director/Owner.
Qualifications: MSc (Eng. – Enviro) UKZN, BSc (Chem and App Chem) UKZN, HED UNISA. RMPASA and Plant Science Consultants Association (PSCA) attendance for GHS training.
Professional Affiliations: RPMASA, IWMSA, PSCA.
Professional Registration: SACNASP: application pending
Company Specialities: Environmental Management, specialising in Waste Management, Hazardous Waste, Legal aspects, GHS: UN Standards Safety Data Sheet Compilations for Hazardous chemicals, Agri-Remedies (New standards) and fertilizers (New standards).

Experience:

- **Regulatory DAEA/EDTEA:** Pollution and Waste Management: Acting Assistant Manager ILembe DM 2006 - 2009.
- **Corporate: SAPPI Mandeni:** 2009 – 2013: Environmental Specialist: SHEQ systems, landfill site management, waste management, legal compliance for permits licences, waste classifications, water permits, waste permits, etc.
- **Own Business: Anne Bindoff Consultancy: As above**
  Clients:
  - **Sappi Mandeni:** Hazardous waste removal.
  - **INDIFLORA: Brookdale Assessment Centre** - Rehabilitation: Waste removal for legal compliance.
  - **Aquasol:** SDS and labels, HCA and DALRD new requirements.
  - **NCP Chlorchem**: Waste assessment.
  - **Intellichem:** Tremcards supply.
  - **IFF:** Tremcards supply.
  - **SAPREF:** Tremcards supply.
  - **Bowisolve:** Legal requirements for road transportation of waste/Hazardous waste.
  - **Andermatt Madumbi:** Agri-remedies SDS assessments and advisory.
  - **RPMASA:** GHS training for Safety Data Sheets.
  - **IWMSA:** Hazardous waste management training.
  - **ECOGUARD:** Agri-remedies SDS compilations – new requirements and advisory.
  - **Aquasolve:** Supply of Safety Data Sheets: Fertilizers, new agricultural standards as per Dept of Labour HCA requirements.
  - **Dow/Corteva:** SDS advisory and tremcards supply.
  - **BPL**: Tremcards Supply.
  - **WALLACE AND GREEN ENVIRONMENTAL SPECIALISTS**: Waste Specialist
    - Motivation in support of the removal of Sumitomo Mill waste ash and rubber compound from definition of waste.
    - Motivation in support of the removal of various waste streams from Illovo mills: Eston, Noodsberg, Gledhow mills.
    - Motivation in support of the removal of various waste streams from Umfolozi Sugar Mill.
  - **ILLOVO SUGAR MILL:**

- Motivation in support of the removal of various waste streams from Illovo Sezela Sugar Mill:

1. INTRODUCTION

Sezela is a small town on the mouth of iSezela River in KwaZulu-Natal, South Africa. The town is 78.7 km south of Durban. It is notable for its large sugar mill. In 1915, the Reynolds Brothers opened a sugar mill at Sezela. In 1974 the Furfural plant was built. This was later purchased by C. G. Smith, then by Illovo Sugar Ltd in 1994, and finally by Associated British Foods. (Reference: https://en.wikipedia.org/wiki/Sezela#:~:text=following%20a%20trail.-,History,finally%20by%20Associated%20British%20Foods, and correspondence from Sezela Mill.)

The Illovo Sezela Sugar Mill (ISSM) is located in the Sezela Village, which was built around the mill to house the employees. The Sezela Village is located in the Umdoni local municipality within the Ugu District municipality Kwazulu Natal province. (Reference: https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2021/02/Umdonii-Municipality-20202021-IDP-1-2.pdf.). Sezela is classed as a Natal Coastal cane growing area.

The total population of Umdoni as of 2017 was recorded at 154 427. This constitutes 22% of the total population of the Ugu district. The population in Umdoni grew significantly after 2009 due to in-migration driven by perceived employment opportunities. The Park Rynie industrial development attracted people from surrounding municipalities who sought employment due to the development. The majority of people who are of working age in Umdoni are not economically active. This means that 54% are neither employed nor unemployed. The Municipality is dominated by young people, who are the main driving force behind economic activity in terms of the labour force composition. 11,5% of the economic sector are from agriculture, forestry and fishing activities. 16% constitutes manufacturing of which ISSM forms a big component. (Reference: https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2021/02/Umdonii-Municipality-20202021-IDP-1-2.pdf.).

Figure 1: Google Earth photo of the Illovo Sezela Sugar Mill in Umdoni local municipality within the Ugu District Municipality: KZN; shows the location of the mill and the surrounding areas. The mill is surrounded by:

- The Sezela River Estuary,
- Small village of Sezela,
- Sugar cane.

The mill lies within the Maputaland-Pondoland-Albany Hotspot Region an area described by Conservation International as “Biodiversity Hotspot. The hotspot’s vegetation is comprised mainly of forests, thickets, bushveld and grasslands. It is for this reason that any activities within this area be careful assessed for possible risks and be appropriately managed.

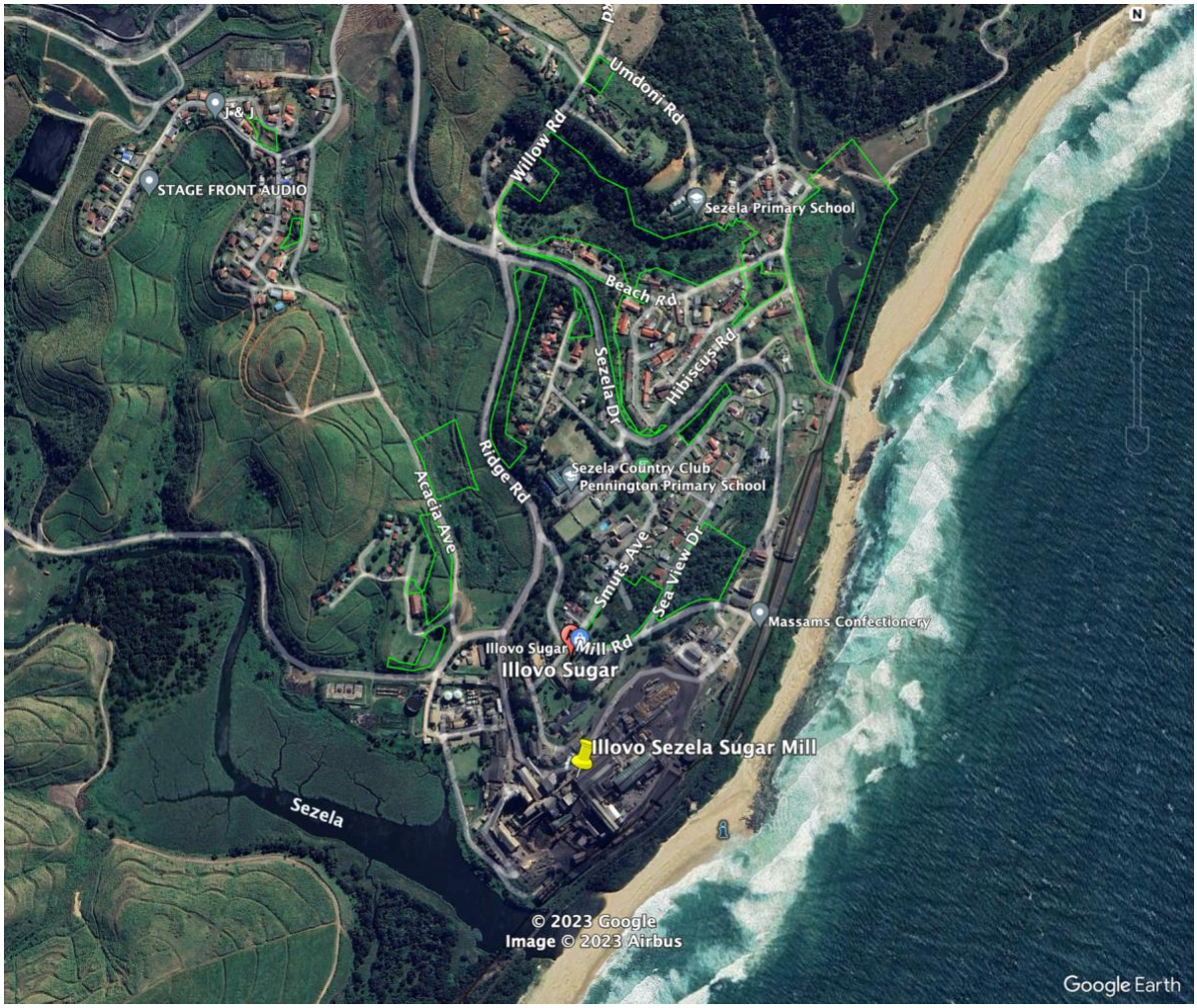

Figure 1: Google Earth photo of the Illovo Sezela Sugar Mill in Umdoni local municipality within the Ugu District Municipality: KZN.

ISSM GPS coordinates 30°24'42.85"S. 30°40'38.96"E.

There are around 72 commercial growers that supply about 721,000 tons of cane and around 3051 small scale growers which supply about 114 000 tons to the mill. The mill crushes approximately 2.05 million tons of sugar cane per annum to produce raw sugar. The Downstream Factory produces approximately 19 500 tons of Furfural and approximately 7000 tons of Furfural Alcohol and smaller quantities of other by-products (Diacetyl, 2.3 PD) dependent on orders. The sugar making process is typically a 38 week crushing season which allows for breakdowns, scheduled maintenance stops and weather interrupted cane supply. The factory is shut down for the rest of the off-season ("off-crop") for maintenance.

The following figure, Figure 2 shows the Google Maps image of the four point pin locations identifying the boundaries of the ISSM effluent plant sludge (ETP) dam area.

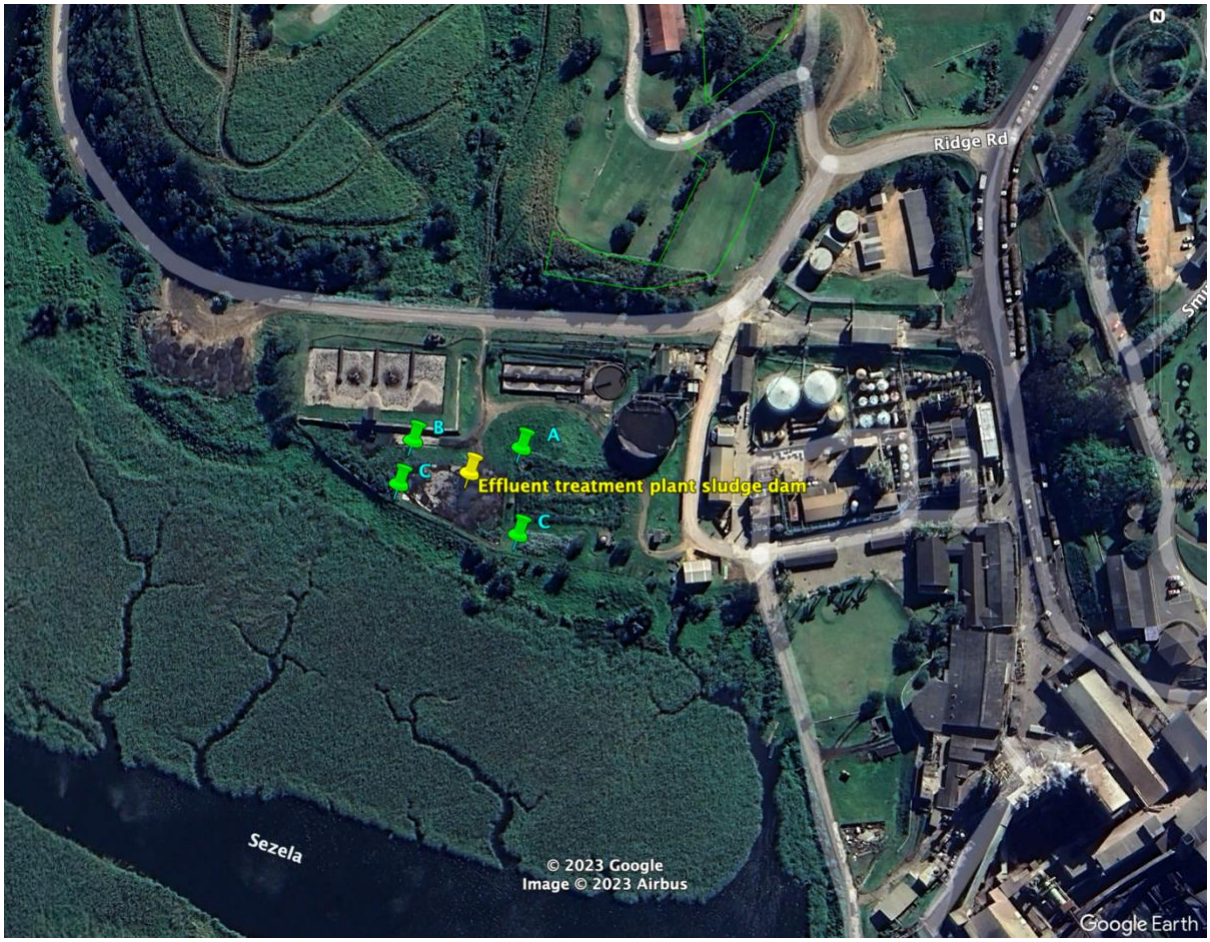

Figure 2: Google Maps image of the four point pin locations identifying the boundaries of the ISSM effluent treatment plant (ETP) sludge dam area.

Table 1: GPS co-ordinates of the Effluent Treatment Plant Sludge Waste area in the ISSM mill site follows below:

Table 1: GPS co-ordinates of the Effluent Treatment Plant Sludge Waste area in the ISSM mill site

GPS CO-ORDINATES AT CORNERS OF EFFLUENT TREATMENT PLANT SLUDGE WASTE GENERATING FACILITY.	Pin Locations	LATITUDE			LONGITUDE		
	A	30°	24'	39.12"S	30°	40'	25.64"E
	B	30°	24'	40.43"S	30°	40'	25.57"E
	C	30°	24'	39.67"S	30°	40'	23.49"E
	D	30°	24'	39.01"S	30°	40'	23.74"E

Waste sludge will be removed from the storage areas as presented in figure 2: shows the Google Maps image of the four point pin locations identifying the boundaries of the ISSM effluent treatment plant (ETP) sludge dam area.

Figure 6: shows the Sezela Mill sensitivity map for the sensitive sections of the surrounding environment that could be affected should there be spills from the waste streams presented in Section 5.7.3.1 Effluent Treatment Plant gives the areas that require particular attention due to their environmental sensitivity.

This report serves as a basis for the application to remove the sludge waste streams from the definition of waste as per the NEM:WA legal requirement. It is compiled as the basis for the risk assessment and the risk management plan to beneficiate the ETP sludge waste stream. It focuses on managing the EFT sludge waste stream as a beneficiated product.
This report fulfils the requirements as set out in the legislative framework given in Section 2 below.

2. LEGISLATIVE FRAMEWORK

2.1. Acts:

- The Constitution of the Republic of South Africa, Act 108 of 1996
- National Environmental Management Act (NEMA): Act No 107, 1998. 27 November 1998. (NEMA)
- National Environmental Management: Waste Act. (NEM:WA) No. 59 of 2008
- The National Environmental Management: Waste Amendment Act (NEM:WAA), 2014 (Act No 26 of 2014)
- National Environmental Management: Waste Act (59/2008): National Waste Management Strategy, 2020 (NWMS)
- National Road Traffic Act (RTA), No. 93 of 1996
- Occupational Health and Safety Act (**OHSA)** no: 85 of 1993

2.2. National Norms and Standards. Listed Activities and other relevant documents

- NEM:WA Regulation 331 National Norms and Standards for the Remediation of Contaminated Land and Soil Quality. 2013
- The Framework for the Management of Contaminated Land, Department of Environmental Affairs (DEA), May 2010
- National Norms and Standards for the Storage of Waste. 2013
- NEM:WA (Act 59 of 2008) Government Notices (23 August 2013):
    - R.634 Waste classification and Management Regulations
    - R.635 National norms and standards for the assessment of waste for landfill disposal
    - R.636 National norms and standards for disposal of waste to landfill
- National Environmental Management: Waste Act (59/2008): Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste (18 July 2018)
- **SANS 10234 (2019)(2nd ed):** Globally Harmonized System (GHS) of Classification and Labelling of Chemicals
- **GHS:** UN Standards Purple Book 9th ed

3. ILLOVO SEZELA SUGAR MILL (ISSM) CONTACT DETAILS

Name: Illovo Sugar (South Africa) (PTY) Ltd
Physical address: 1 Smuts Drive, Sezela in Kwazulu-Natal. 4215.
Contact person
Name: Nicole Geoffrey
Portfolio: SHERQ Officer: Environment & Risk
General Mill Contact no: 039 975 8000
Tel: +2731 450 7821| **Mobile:** +2778 496 9843
Email: NGeoffrey@illovo.co.za

4. ILLOVO INTEGRATED MANAGEMENT SYSTEM

As part of the mill operations, the Illovo Integrated Management System which includes the SHERQ Management Systems has been adopted for best practice in the industry and is adhered to by all its sugar mills. In relation to environmental responsibility, the following is an extract from Illovo's Code of Conduct and Business Ethics (see Attachment: 1 Illovo Group Code of Conduct and Business Ethics).

4.1. Environmental management

Excerpts from the Illovo Group Environmental Management document are given as follows:

- Illovo supports and encourages operating, manufacturing, farming and agricultural practices and production systems that are sustainable.
- As an environmentally sensitive business, Illovo supports a precautionary approach to environmental challenges and is committed to promoting environmental responsibility and encouraging the development and diffusion of environmentally friendly technologies in our operations.
- Suppliers should adopt a precautionary approach to environmental challenges and continually strive towards improving the efficiency and sustainability of their operations, including water conservation programmes, initiatives to promote greater environmental responsibility and encourage the development and diffusion of environmentally friendly technologies.
- The following aspects of environmental management will be included in the assessments of Suppliers:-
    - they should be aware of, and be able to demonstrate compliance with all current environmental legislation that may affect their activities;
    - they should conduct an environmental review of all aspects of their products and services.
- Any enforcement, improvement or prohibition notices served on a Supplier within the last three years by any competent authority must be disclosed and will be reviewed.

Illovo has developed its own Integrated Risk Management System (IIRMS) to ensure that the standards to which the business conforms are unified under a single platform, guiding and measuring compliance.

IIRMS guidelines have been developed from best practices in the Illovo Group, and from best practice in their industry where necessary. IIRMS assists in the management of environmental risks at Illovo and ensures that these standards are implemented by the whole group.
Many of the Illovo Group sugar factories already operate to high environmental standards through a circular economy model where outputs such as molasses, vinasse, condensed molasses solids (CMS), bagasse, bagash/boiler ash, and sludge are turned into co-products; such as energy feedstock, fertiliser, soil conditioning nematodes and bioethanol. This is aligned to the circular economy, meaning that, as much as possible, we eliminate waste, and re-use resources, putting them back into the process.
Illovo Sezela Sugar Mill (ISSM) has its own inhouse specific management system protocols.

5. FACILITY WASTE GENERATING PROCESS

Refer to Figure 3: Sezela Process Flow. This illustrates the overall process flow diagram of the mill to produce sugar and the accompanying waste streams: bagasse, filter cake and ash. The process is given in detail to show that the entire production process is integrated and is on a closed loop water cycle, to conserve water to minimise the use of external water source. Hence the inputs are seen in the waste streams.

It must be noted that for the purpose of this report and the application for waste exclusion of Effluent Treatment Plant Sludge waste from the definition of waste, a brief overview of the main processes that generate the waste streams have been discussed below.

5.1. Brief overview

The purpose of this section is to satisfy the legal requirement for the description of the components that make up the Effluent Treatment Plant Sludge waste stream.

5.2. Waste stream - Effluent treatment plant (ETP) sludge.

This process is described in detail in section 5.7.3.1 below and the inputs as well the water cycle will be described. (Refer to Figure 3: Sezela Process Flow):

The ETP is a conventional activated sludge Plant (CAS). It accepts effluent that emanates from site plant:

- wash downs,
- sewage -
    - The mill has been in agreement since 1999 with the local municipality to assist with the treatment of sewage from the village as they were unable to do so. An agreement with the mill and the municipality has since been standing.
- storm water.

The raw effluent undergoes:

- physical screening to remove the bulk inflow solids. At this point there is a facility to remedy any contamination should this occur.
- Further along there are 2 grit settling chambers to remove any remaining solids such and ash and sand.

- The liquid is channelled into the pre-treatment Aerated tank , a biological reactor using micro-organisms to consume biodegradable organic components in the effluent water
- The activated sludge mixed liquor suspended solids (MLSS) from the aerator pre-treatment tank is allowed to flow into the activated sludge tank.
- The clarifier allows the activated sludge to settle out of the mixed liquor,
- Clear treated effluent water (final effluent) is recovered from the top of the clarifier.
- The final effluent is either discharged to the:
  - Maturation River, or
  - directly to the final effluent pump station which will transfer it to one or more of its destinations:
    - the Boilers for use in the scrubbers, or
    - to sea.

The sludge from the underflow is recycled back to the head of the works. During the crushing season the excess sludge is wasted via the sludge recycle pumps (5%) to the volute where it is filtered in the de-waterer with the:

- recovered water draining into maturation pond and

It is then conveyed by the screw pump into the trailer for dumping.

The details of the areas that generate the effluent are given in the section 5.7.3.1 below.

5.3. Process description to produce sugar

Refer to Attachment 3: Sezela Mill Process Description.docx for a detailed description of the process.

The following section briefly describes the sugar milling processes to produce raw sugar. The purpose of this section is to give an overall viewpoint of the inputs into the process to show where and how the various waste streams are generated. ISSM recycles the process water back into the system, hence the waste water is exposed to several process streams.

Refer to Figure 3: Sezela Process Flow. The following is the process description obtained from the Sezela Sugar Mill directly.

5.3.1. Delivery

Sugar cane comes in from the growers by vehicle. The majority of the growers make use of contract haulers while some of the large commercial growers haul their own cane.

The vehicles cross into the mill over a weigh bridge where they are check weighed and logged through the cane procurement system. The vehicles are weighed on the way out, after dropping off their cane and the difference in the in and out weights is the amount of cane delivered.

On entering the mill the vehicles may be off loaded by Hilo unloader cranes onto spiller tables.

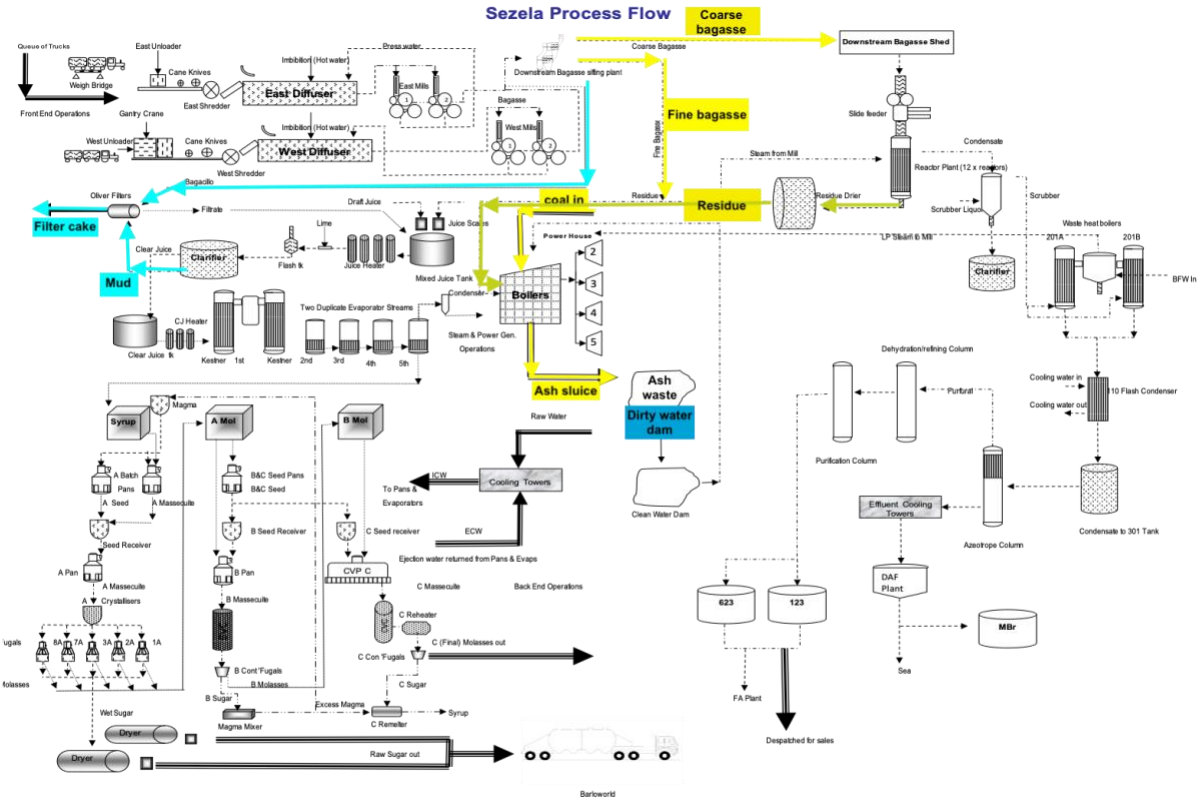

Figure 3: Sezela Process Flow.

5.3.2. Juice Extraction

There are 4 conveyors between the "spiller table and the Diffuser.

The third conveyor conveys the cane from the "Cane preparation" section where the cane is among others:

- chopped up into manageable pieces,
- then shredded.
- a series of hammers, which flatten the cane to expose the cells in the cane for the diffusion process.

From the third carrier the cane drops down again onto the fourth carrier which feeds cane evenly across the diffuser inlet.

The diffuser is a long steel housing. It has a conveyor inside which carries the cane through the diffusion process:

- The diffuser is like a:
    - multi stage percolator with hot water passing through the prepared cane bed in each stage and
    - extractes the sucrose from the cane fibre.

The pulp leaving the diffuser is now known as "Bagasse". There are a series of Bagasse conveyors known as B conveyors. The bagasse passes from the diffuser to dewatering mills which operate in

parallel. The mill presses the water out (called "press water") which is collected and sent back to the diffuser.

The bagasse conveyors carry the bagasse to downstream where it is processed in the reactors for Furfural production. The processed bagasse exiting the reactors is called "Residue" and this is then transported via conveyors to the boilers and the excess is rejected and stored in the Bagasse/Residue shed.

5.3.3. Raw Sugar Process

The juice exiting the diffusers is pumped to the mixed juice tank. From the mixed juice tank the juice passes through heaters and then clarifiers to remove the ash and mud from the mixed juice. Clarification is done by heating the juice, adding:

- heat,
- Milk-of-lime,
- Flocculant,

Allowing the resulting mud (Miala) to settle out in large decanting vessels called Clarifiers.

The settled mud from the bottom of the clarifiers is taken to the Oliver Filter, where it is dewatered.

- The liquid pressed out of this mud is returned back to the mixed juice tank
- The dewatered mud is called filter cake where is is removed for disposal.

Filter cake generation: approximately 2000 tons per month.

The clear juice, now free of mud is returned to the process where it is:

- then concentrated into a heavy syrup in evaporators.
- Sugar is made in Vacuum Pans by growing small grains of sugar to a required size by introducing syrup into the pan under controlled conditions.
- the resultant product, Massecuite (sugar crystals suspended in molasses), is struck into the Crystallizers where the crystal continues to grow.
- The Sugar Crystals are separated from the Molasses by centrifuging the Massecuite which retains the crystal but allows the Molasses to drain off.
- The Molasses is processed further to recover sugar,
- The sugar is sent to driers,
- the final exhausted molasses (Final Molasses) is stored in bulk tanks, prior to sale for the manufacture of ethanol.
- The Raw Sugar is melted and sent on for further processing in the refinery to remove the colour components in the sugar.

These steps all contribute to the waste streams due to the spillages during processing of the various components. These spills are washed down with water into the effluent system for treatment.

Sezela produces approximately:

- 85,000 tons of molasses and
- 225,000 tons of Raw Sugar

per season.

5.4. Downstream products Process.

A portion of the bagasse leaving the cane sugar juice extraction process is used in the 'Downstream products process'. The remaining portion is sent for use as fuel in steam and power generation. The bagasse entering the Downstream process is separated into coarse and fine fractions. The coarse fraction is processed further and the fine fraction is sent for use as fuel in steam and power generation.

The coarse fraction of the bagasse is fed into one of several reactors where steam is introduced. This process extracts Furfural from the bagasse. The 'cooked' bagasse is discharged as bagasse residue which is returned for use as fuel in steam and power generation.

5.5. Steam and power generation

Bagasse, bagasse residue and coal are used as fuel sources in the steam generation plant which consists of four boilers:

- Boiler 1 is fuelled with bagasse only,
- boilers 2, 3, 4 use mixed fuel. :

Approximately:

  - 640,000 tons of bagasse and
  - 40000 tons of coal are burnt

per 38 week season (3-year average).

The steam exhausted from the turbo-alternators or TA's is used as a heating medium in the raw sugar processes. The condensate resulting from the heating processes is returned to the boilers to be converted to steam.

5.6. Downstream processing Furfural production

The Furfural Plant production season is directly linked to the Sezela Sugar Mill. refer to Figure 4: Furfural Plant process flow, to follow the waste streams used and generated from this process.

FURFURAL PLANT FLOW DIAGRAM

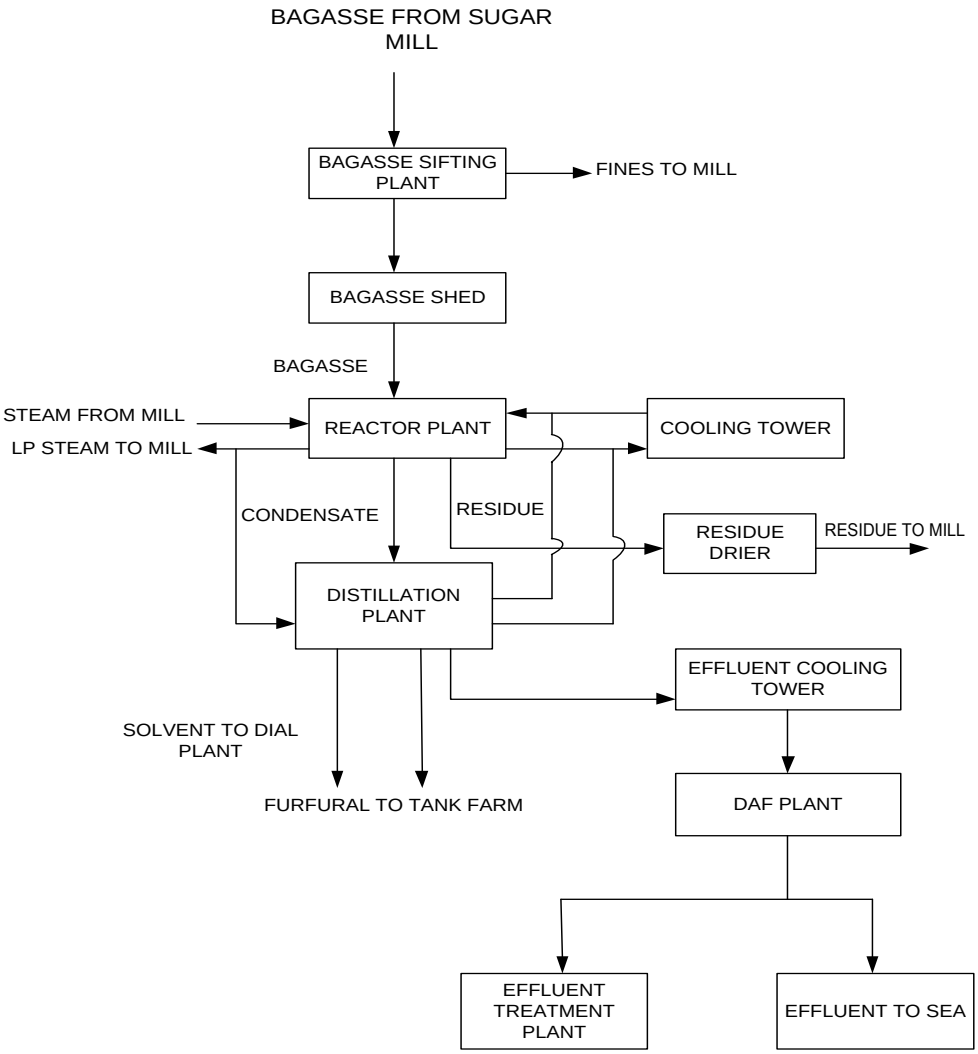

Figure 4: Furfural Plant process flow

Bagasse is received from the Sezela Sugar Mill. It is then sifted in the Sifting Plant.

The rotary screens used to separate the bagasse into two fractions referred to as:

- coarse bagasse which is conveyed to the Reactor Plant where the furfural manufacturing process begins.
- fine bagasse - which is returned to the Mill
- excess bagasse is conveyed from the reactors to the bagasse shed.

Bagasse is fed into the reactors through various feeders and processes. The reactors are cylindrical pressure vessels. These are pressurised with steam, a chemical reaction takes place in the bagasse and furfural is produced. The spent bagasse is discharged from the base of the reactor as residue. The furfural leaves the reactors in a steam/vapour phase which then enters the scrubbers to clean out the small particles of bagasse and waxes carried over mixed in the furfural vapour phase. These are removed in scrubbers as the vapour passes through the scrubber liquor. The scrubber liquor has three main sources;

- cooling tower blow down,
- raw water (used in emergency situations) and
- process recycle liquor.
    - This liquor is the cleaned effluent from the Dissolved Air Flotation (DAF) Plant.

The solids in a slurry are discharged from the bottom of the scrubbers to the clarifier. The furfural rich vapour is then partially condensed in the waste heat boilers.

The furfural rich vapour heat is transferred to the water in the steam drum to produce L.P. steam. The L.P. steam is used in the:

- distillation plant,
- the sugar mill and
- the residue drier.

The distillation plant receives furfural condensate from the reactor section. This is fed into the Azeotrope column where it is concentrated to between 16,5% and 17,5% furfural.

- The effluent from the column goes to the cooling towers and is then pumped to the DAF Plant before being pumped to the sea and or the MBR.
- The concentrated furfural is decanted and the water phase is returned to the Azeotrope Column.
- The furfural phase is fed to the dehydration/refining column and then to the purification column to remove ± 1% impurities from the furfural to increase furfural purity to 99.5% minimum. The final product is pumped across to tanks where it is used either as:
    - feedstock for FA products or
    - despatched for sales.

5.7. Waste and Effluent streams

5.7.1. Ash

Has been described in section 5.5 Steam and power generation.

5.7.2. Filter cake

Solid waste from the cane juice clarifier is sent to the Oliver mud filters and the waste after the Oliver filters is called filter cake.

5.7.3. Liquid effluent

Refer to Figure 5a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant, and Figure 5b: Sezela Mill effluent treatment plant, show the details and location of the features for liquid treatment as given in the following sections.

.

Water from the factory is let down to dams via different processes depending on it's type and after filtration is used for cooling and "Scrubbing" of boiler flue gasses. Very little water is used as 70% of the cane is water.

The Sezela Waste Water Recovery Plant consists of two Waste Water Treatment Plants which are separate, the Effluent Treatment Plant (ETP) and a Membrane Bio-Reactor (MBR).

5.7.3.1. Effluent Treatment Plant (ETP)

The ETP is a conventional activated sludge Plant (CAS). It accepts effluent that emanates from site plant:

- wash downs,
- sewage and
- storm water.

The ETP receives waste water from six different sources around the Sezela Complex. These are the:

- North Outfall which is situated on the North side of the Sugar Mill's molasses tank, the
- Stores Sump which is located near the Main Stores on the North side of the East Diffuser,
- the Boilers Sump along the main factory road near Boiler 4,
- New East Drain situated at the bottom of an embankment below the Downstream Boilershop.
    - The East drain is a collection point for the Furfural plant:
        - washing,
        - filtration plant washing,
        - cooling tower,
        - the Boilers emergency dam and
        - storm water from all these areas.
- the 50 ton tank which collects effluent streams from the:
    - FA Plant and
    - Diketones Plant and finally
- sewage from the village. The mill has been in agreement since 1999 with the local municipality to assist with the treatment of sewage from the village as they were unable to do so. An agreement with the mill and the municipality has since been standing.

Samples and readings are taken at various points of the effluent process and the Incoming Combined Total Volumes and quality are monitored for pH, TDS and COD.

Near the inflows is situated a Bar Raked Screen which removes the bulk of the inflows solid waste such as bagasse and rags which is then deposited into drums. Nutrients such as phosphoric acid and urea are added before the rake into the incoming effluent after an incident of contamination to assist with normalising the plant.

Situated further along the channel are two grit settling chambers which serve to remove any remaining solids, such as ash and sand, in the effluent stream. After this the channel runs directly to the pre-treatment Aerated tank with the available diversion route to the Activated Sludge Reactor.

The Aerated tank is used to store the mixed liquor viz incoming waste water, dosing chemicals and recycle activated sludge. The Aerators facilitate pretreatment of the waste water by agitating the mixture. Two large floating surface aerators are also installed in the pre-treatment tank. The

agitation produces a spray of droplets that absorb oxygen from the air before falling back into the aerated tank.

The activated sludge reactor is a biological reactor that uses micro-organisms such as bacteria to consume biodegradable organic contaminants from waste water. The waste water is generally contaminated with bagasse, sugars and traces of organic chemicals that are manufactured at the Sezela complex. The activated sludge reactor has 3 vertical surface aerators similar to the ones in the aerated pre-treatment tank. The solids content of this tank is maintained at a concentration of between 6 000 and 10 000 ppm in order to obtain a high purification efficiency. The activated sludge mixed liquor suspended solids (MLSS) from the aerator pre-treatment tank is allowed to flow into the activated sludge tank.

The clarifier allows the activated sludge to settle out of the mixed liquor. Clear treated effluent water (final effluent) is recovered from the top of the clarifier through a series of V-Notches. The final effluent is either discharged to the Maturation River or directly to the final effluent pump station which will transfer it to one or more of its destinations i.e. the Boilers for use in the scrubbers or to sea.

The sludge from the underflow is recycled back to the head of the works by one or both of the two sludge recycle pumps. During the crushing season the excess sludge is wasted via the sludge recycle pumps (5%) to the volute where it is filtered in the de-waterer with the:

- recovered water draining into maturation pond and

It is then conveyed by the screw pump into the trailer for dumping.

- During the season the final effluent is pumped to the Sugar Mill Boilers to be used as scrubber water for the boiler stacks.
- During off-crop the final effluent is pumped to the sea.
    - When the final effluent is found to contain a solids content that is greater than 25 ppm and or a Chemical Oxygen Demand (COD) that is greater than 100 ppm, it is diverted to the Maturation River to allow further biological treatment and the excess solids to settle.

5.7.4. Membrane Bio-Reactor (MBR)

The MBR is a modern activated sludge plant capable of treating higher COD (Chemical Oxygen Demand) effluents. It is dedicated to the treatment of the:

- Furfural Plant Effluent from the Azeotrope column via Effluent Cooling Towers and
- the DAF Plant.

The MBR is a biological Activated Sludge Treatment Plant to treat Acid Water from the Furfural Plant Effluent which is currently being discharged to the sea under the licence issued from DEA — Oceans and Coast. The waste water has a COD of ± 18 000 ppm which is too high for treatment in the Conventional Activated Sludge Plant. The MBR treats effluent from the Azeotrope column via the cooling tower and DAF (Dissolved Air Flotation) Plant. The major liquid effluent stream form the furfural azeotrope distillation consists of mainly water with 1.5% acetic acid.

This reactor is equipped with two large Fine Bubble Air Blowers (FBDA 1 & 2) and a smaller Coarse Bubble Membrane Air Blower. The FBDA blowers pump air into the bottom of the reactor. The treated water (Permeate — PMT) is separated from the Activated Sludge by a series of semipermeable membranes mounted on a platform that is situated on the North side of the tank. The screens in the membranes catch the solids. The treated effluent is then pumped to sea during off-crop and in season joins final effluent to the mill.

Sezela has 2 raw water supply dams and a boiler scrubber water recovery dam system which catches the solids and passes the clear water on to the Clean Water Dam which is a holding dam from where water is fed back to the factory for reuse in the boiler scrubber system.

The effluent plant discharge water is fed into the Boiler scrubber water recovery system. The Sezela effluent plant is one of the few effluent treatment plants in the country that reuses water rather than discharging into a natural water course. Figure 5a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant, and Figure 5b: Sezela Mill effluent treatment plant, show the details and location of the features for treatment as given above.

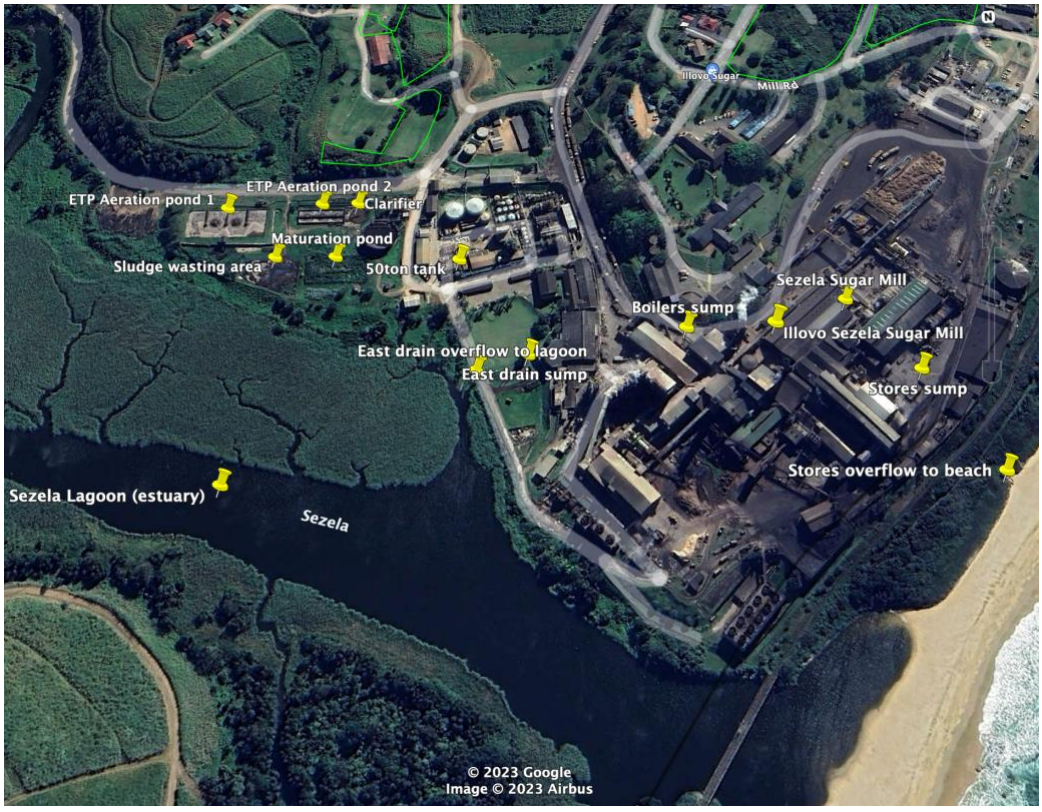

Figure 5a: Google Earth screen shot from the WULA showing the main features of the effluent treatment plant

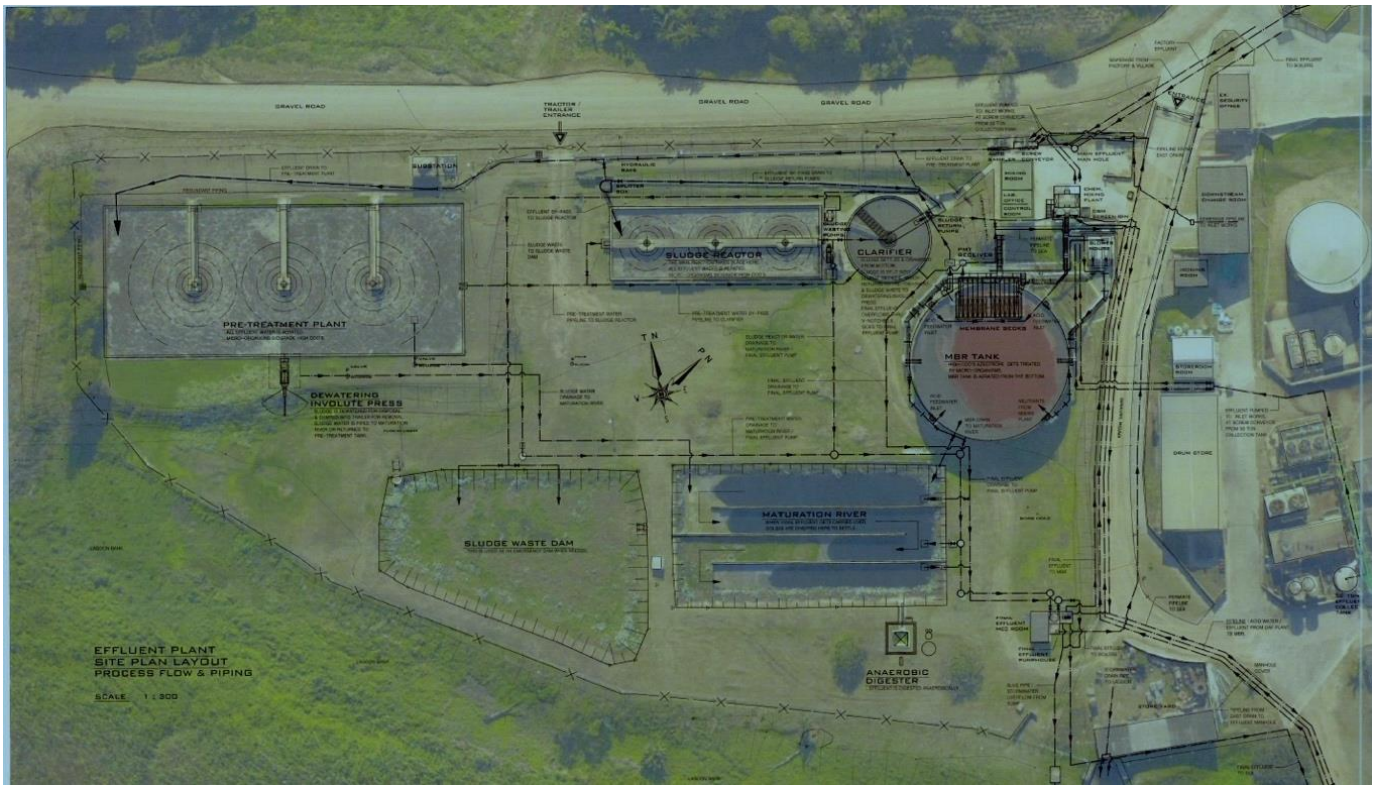

Figure 5b: Sezela Mill effluent treatment plant showing the different processing plants.

Figure 6: shows the Sezela Mill sensitivity map for the sensitive sections of the surrounding environment that could be affected should there be spills from the waste streams.

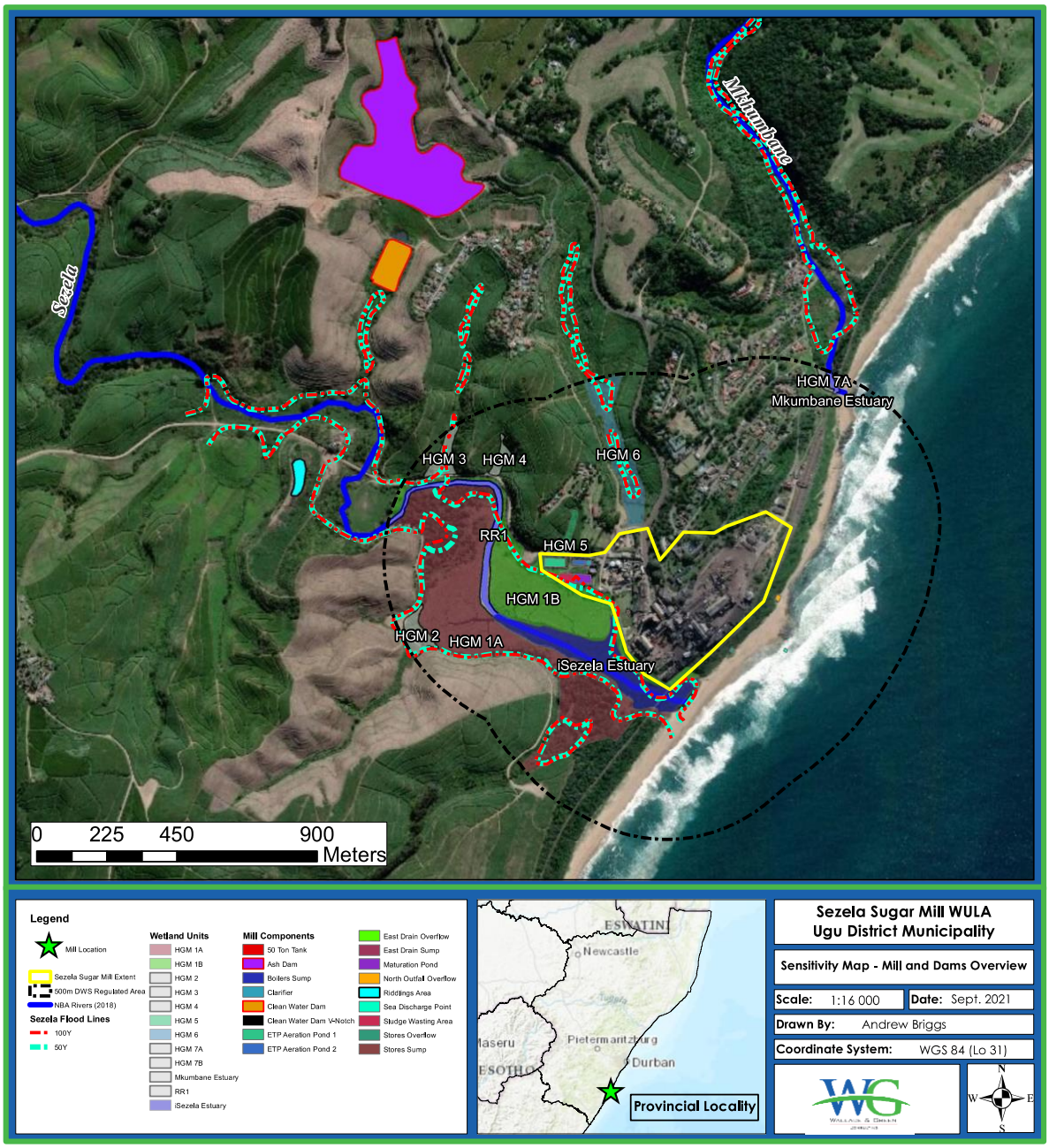

Figure 6: Sezela Mill sensitivity map for the sensitive sections of the surrounding environment that could be affected should there be spills from the waste streams.

These are important to note for management of the wastes and the importance of beneficiating the waste.

5.8. Sludge waste recipient

Sludge from the ETP is the waste stream relevant to this application for exclusion from the waste stream. It is to be used as a soil enhancer/fertilizer on agricultural fields.

5.9. Waste generated

Ash: +- 100 000kg per day (should be more than this – based on 1 day sample)
Filter cake: 2000 tons per month

Sludge from Clear Water Dam: 45tons/day (15000tons per annum – desludging is done annually).
Effluent treatment plant sludge: 4tons per day

5.10. Waste Removed

Ash: The intention is to use all waste generated to divert from landfill.
Filter Cake: +- 25 tons per day during season
Sludge: The intention is to use all waste generated to divert from landfill.

6. WASTE SLUDGE: USES IN THE AGRICULTURAL INDUSTRY.

This brief section will give the conclusions for research work done on the use of sugar industry effluent sludge waste as rich carbon source to beneficiate soils in order to enrich them and to ultimately improve crop production.

The following citation gives the results and conclusion from: Dotaniya ML, et al. (2016;5(3):185–94). (https://link.springer.com/article/10.1007/s40093-016-0132-8).

- Results

Application of sugar industries by-products, such as press mud and bagasse, to soil improves the soil chemical, physical, and biological properties and enhanced the crop quality and yield. A huge possibility of sugarcane industries by-products can be used in agriculture to cut down the chemical fertilizer requirement. If all the press mud is recycled through agriculture about 32,464, 28,077, 14,038, 3434, 393, 1030, and 240 tonnes (t) of N, P, K, Fe, Zn, Mn, and Cu, respectively, can be available and that helps in saving of costly chemical fertilizers.

- Conclusions

Application of sugarcane industries by-products reduces the recommended dose of fertilizers and improves organic matter of soil during the crop production. It can also be used in combination with inorganic chemical fertilizers and can be packed and marketed along with commercial fertilizer for a particular cropping system. That helps to reduce the storage problem of sugarcane industries by-products across India."

The results of the research work done on the use of the waste streams to enhance soils and the sugar cane crop are very positive. The caution used in the applications of the waste streams on soils are the toxic metallic components in these waste streams. Thus careful management and monitoring of the process with agronomists is necessary to avoid any potential of poisoning the soil and the crop. However, further research is being done on the combinations of the waste streams in order to potentially reduce the toxicity of the waste streams.

The sludge from the ISSM waste streams is a source of nutrients as can be seen in the processes that generate the waste streams which are ultimately collected in the respective sludge dams. The nature of the waste sludges will be discussed in Section 8: Methodology used to assess the chemical/hazardous nature of the waste to be excluded, Section 9: Chemical and technical specifications – pre-beneficiation, and section 10: Chemical and technical specifications – post-

beneficiation. The basis of the risk assessment and risk management plan will be based on these results.

7. CONSEQUENCES OF NOT RECYCLING OR REUSING THE ETP SLUDGE

The only recourse for the waste sludge if it is not reused or recycled is to pre-treat and then dispose to landfill. Landfilling is the option chosen by many to dispose of waste as the most convenient option. Unfortunately landfilling as a waste management practice contributes to unnecessary high airspace use. This leads to very costly sourcing and development requirement for additional landfill space. So, in line with the NEM:WA: National Waste Management Strategy (NWMS - 2020); the focus is on amongst others to divert waste from landfilling and to implement the circular economy principles to beneficiate the waste as a resource in a safe and responsible manner.

Should the sludge not be permitted to be used as a fertilizer on the sugar cane fields, the requirement would be for ISSM to dispose to a permitted and properly managed landfill site which will incur the following:

- Cost of:
  - Pre-treatment to enable the disposal of this waste stream to landfill,
  - Laboratory for assessment and classification once treated.
- Landfilling fees;
- Fuel which is changing and generally increasing monthly in 2023,
- Driver salaries,
- Truck fees and maintenance.
- The filling up of landfill space much quicker with treated sludge.
- Opportunities to earn an income for those with no or low income:
  - youth,
  - women and
  - entrepreneurs in general,

because of:

- The potential users of this waste stream have opportunities that may be lost due to the cost of buying the extra fertilizers to make up for the lost rich macro and micro nutrient value of the sludge. This would lead to other effects such as factors leading to the inability for the farmer to employ the local community to work the land to maximise the sugar cane output for the farmers. The sugar industry together with the unemployment rate are not in a healthy state currently, in South Africa.
- The cost to ISSM to treat the waste stream to bring it into compliance:
  - reduce the moisture content < 63%, while balancing the levels of heavy metals which will increase in concentration with the loss of water. This may require ISSM to dilute the sludge with a dry material, thereby adding to the bulk and hence the cost to transport and the cost to landfill.

7.1. Benefits of reuse and recycling

7.1.1. Intended use of Sludge

The intention is to use the sludge as a soil enhancer/fertilizer for agricultural land.

7.1.2. Benefits of Reuse and recycling

The benefits of reusing and recycling the sludge aligns with the objectives of the South African National Waste Management Strategy (NWMS) - 2020 and are also aligned with the Sustainable Development Goals (SDG) 2030. Examples of the relevant SDG's:

- **SDG 3**: To avoid/minimize waste related environmental factors that prevent ill-health and disease.
- **SDG 8**: Promoting the waste management sector as a key contributor to overall economic growth and development.
- **SDG 9**: Use of natural resources to improve people's standard of living without damaging the environment.
- **SDG 12**: Through: ensuring production patterns, implementing initiative that reduce waste, promote re-cycling, re-use.

The NWMS 2020 strategy is directing South Africa to a future with zero waste in landfills. This will be achieved through eight strategic goals, two of which are relevant for this report namely:

- **Goal 1:** Promote waste minimisation, re-use, recycling and recovery of waste. Focuses on implementing the waste management hierarchy, and with the ultimate aim of diverting waste from landfill.
- **Goal 8:** Establish effective compliance with and enforcement of the Waste Act. Ensures that everyone adheres to the regulatory requirements for waste management, and builds a culture of compliance.

The re-use of the sludge benefits:

Note: the sludge will require monitoring in the soils due to the nature and level of the constituents

- The company because of cost savings of diverting from landfilling.
- Not having to treat the sludge for disposal, but to maximise the benefit of the sludge.
- The soil on the farmland because of the moisture of the sludge, although high, benefits the soils with the moisture and the nutrients.
- The community; through employment of people within the community due to cost savings through not having to buy commercial fertilizer.
- Potential to supply small community farmers to assist them with their soil management for growing their own food.
- Business creation and thus job creation.
- Investigate ways of reducing the levels in incoming toxic minerals into the effluent stream.
- Investigate other practical uses of the sludge already being used globally and to investigate new uses. One such use would be to generate biogas to generate energy for use on the mill. there is evidence of flashing hence the decomposition process is underway.

By correct management of the waste, the potentially hazardous components will be minimized.

To be able to benefit from this opportunity, the sludges will need to be characterised to understand the chemical and physical nature of the waste streams. It is then assessed for landfilling using the standard criteria and classified by Globally Harmonised Standards (GHS) aligned to the United

Nations standard for health and environmental risk. Understanding these characteristics of the sludge will help to minimise the risk for use for the purpose of soil fertilizer. The following section describes this process and the results describe the nature of the waste.

8. METHODOLOGY USED TO ASSESS THE CHEMICAL/HAZARDOUS NATURE OF THE WASTE TO BE EXCLUDED.

8.1. Rationale

Research work has been done for the use of sludge on agricultural crops.. There are promising results that this may be successful with proper understanding of its chemical makeup. The following section focuses on the chemical makeup of the sludge and the potential hazards and risks these pose in its proposed application. A risk assessment and a risk management plan will be formulated to minimise any harm to people and the environment.

8.2. Characterisation of the waste sludges

The waste sample taken at the ISSM ETP was received at Talbot and Talbot accredited laboratories on 17th October 2022, and testing commenced on the same day. It was tested using the **NEM:WA Norms and standards Regulations** for assessment and classification of waste. See:

For ETP sludge:

- Attachment 3a: Certificate of Analysis,
- Attachment 3b: Waste Assessment and Classification, and
- Attachment 3c: Safety Data Sheet - SDS.

These give:

- the chemical composition from a prescribed list,
- the assessment of the waste for
  - waste type
  - the landfill class
- the GHS classification for any hazards from
  - the physical nature of the waste with any risks associated with it,
  - any risk to health, and
  - any risk to the environment.

The second approach is to determine the hazard thresholds of the chemicals in soils and hence the effect on the environment and the health of the community. The following was used:

- **The Framework for Contaminated Land Rehabilitation (DEA- May 2010) guideline** was used, and compared with the Total Concentration values (TC) obtained as well as the Leachable Concentration (LC) results from the laboratory analyses obtained.

The sludges are then managed appropriately using the mitigation/management provided from the identified risks.

8.3. Results

Note: refer to:

For ETP sludge:

- Attachment 3a: Certificate of Analysis,
- Attachment 3b: Waste Assessment and Classification, and
- Attachment 3c: Safety Data Sheet - SDS.

for the full details of the analyses and assessments.

8.3.1. Waste assessment to landfill :

For ETP sludge:

- GN 636 S5: Current Prohibition/Restriction from Disposal:
    - (1)(c) : Flammable waste with a closed cup flashpoint <61 °C. Analytical value of: 60 - Flash°C.
    - **(1)(q)(ii):** Waste with a moisture content >40% or that liberates moisture under pressure in landfill conditions, and which has not been stabilised by treatment. **Analytical value of: 60 %.**
- GN R636 S5: Future Prohibition/Restriction from Disposal:
    - **(1)(r)(iv):** >6% Total Organic Carbon (TOC). **Hazardous waste with analytical value of: 74%.** (Prohibited from: Aug 2028)
- GN R634: **Overall Waste Disposal to Landfill: Type 0 Waste - very high risk.** Prohibited as per GN 636 S5 given above for current restrictions.
    - Subject to waste treatment and re-assessment per GN R634, the prohibition or restriction may be excluded.
- GN R635 S7, the waste is **chemically assessed as a Type 3 waste,** (60% moisture content as-received analysis), which is low risk.
- **Class C Landfill** (GLB^+).

8.3.2. Physical Characteristics.

- pH was measured at 8.2,
- Moisture content at 60% and
- TOC - 74%.
- Black sludge.
- Odour: Damp odour.
- Closed cup Flash at 60 ^oC.
- No CV.

8.3.3. GHS Classification and Hazard Management

IMPORTANT NOTE: refer to the attachment 3c, Safety Data Sheet (SDS) for full details referred to in this report.

Table 2: Summary of sludge GHS hazard classification

Classification in accordance with SANS 10234:2019:	
Physical: H226, Cat 3: Flammable liquid.	Flammable liquid and vapour.
Health:	Not classified

Environment	Not classified
Overall classification:	**Hazardous** - by way of above properties and/or effects.

The classification in accordance with the SANS 10228:2012 standards is to identify and classify dangerous goods for transportation by road and rail. Table 3 ETP below gives the classification for transportation using road and rail modes.

Table 3: ETP sludge classification for transportation

Class	UN Number	Proper shipping name (Road and rail)	PG
4.1	3175	SOLIDS CONTAINING FLAMMABLE LIQUID, N.O.S	II

8.4. Hazards not otherwise classified:

No data available.

8.5. Composition or information on ingredients in sludge.

Sludge - mixture.

8.6. Identification. Hazards identification. Uses and restrictions on use.

- Sludge Mixture.
- Road & Rail PSN: SOLIDS CONTAINING FLAMMABLE LIQUID, N.O.S

- **GHS hazard category: 3**
- **GHS hazard statements:** FLAMMABLE LIQUID.
- Signal word: WARNING.

- **identified uses:** WASTE - intended for transport by road or rail, and disposal.
- **Uses advised against:** WASTE: if a commercial product residue, not intended for original use. KEEP AWAY FROM clothing. Take precautionary measures against static discharge. DO NOT eat, drink or smoke when using this product. AVOID release to the environment. Collect spillage.

8.6.1. Precautionary measures

Prevention:

- KEEP AWAY FROM clothing.
- Keep container tightly closed.
- Ground/bond container and receiving equipment.
- Take precautionary measures against static discharge.
- AVOID breathing dust, fume, gas, mist, vapours, spray.
- DO NOT get in eyes, on skin, or on clothing.
- DO NOT eat, drink or smoke when using this product.
- AVOID release to the environment.
- Wear protective gloves, protective clothing, eye protection, face protection.

Responses:

- Get medical advice / attention if you feel unwell.
- Fight fire with normal precautions from a reasonable distance.
- Collect spillage.
- IF SWALLOWED: Call a POISON CENTRE or doctor/physician if you feel unwell.
- IF ON SKIN: IMMEDIATELY remove/take off all contaminated clothing. IMMEDIATELY rinse skin with water/shower.
- IF INHALED: Call a POISON CENTRE or doctor/physician if you feel unwell.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- If exposed or concerned: Call a POISON CENTRE or doctor/physician.

Storage

Store in a well-ventilated place and keep cool.

8.6.2. First-aid measures

- **Immediate actions:** IF ON SKIN (or hair): IMMEDIATELY remove/take off all contaminated clothing. IMMEDIATELY rinse skin with water/shower. If exposed or concerned: Call a POISON CENTRE or doctor/physician.
- **Actions to be avoided:** DO NOT eat, drink or smoke when using this product. AVOID release to the environment.
- **Inhalation:** AVOID breathing dust, fume, gas, mist, vapours, spray. IF INHALED: Call a POISON CENTRE or doctor/physician if you feel unwell.
- **Skin Contact:** KEEP AWAY FROM clothing. DO NOT get in eyes, on skin, or on clothing. Wear protective gloves, protective clothing, eye protection, face protection.
- **Eye Contact:** DO NOT get in eyes, on skin, or on clothing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- **Ingestion:** DO NOT get in eyes, on skin, or on clothing. IF SWALLOWED: Call a POISON CENTRE or doctor /physician if you feel unwell.

Protection of first-aiders and notes for attending physicians

- **Physician notes:** Get medical advice / attention if you feel unwell.

8.6.3. Fire Fighting

-
- Extinguishing media and methods: Use extinguishing media suitable to the surrounding fire.
- **Protection of fire-fighters:** KEEP AWAY FROM clothing. Take precautionary measures against static discharge. AVOID breathing dust, fume, gas, mist, vapours, spray. Fight fire with normal precautions from a reasonable distance.

8.6.4. Accidental release measures

- **Personal precautions, PPE:** Wear protective gloves, protective clothing, eye protection, face protection. KEEP AWAY FROM CLOTHING

- **Environmental precautions:** AVOID release to the environment. Collect spillage.
- **Methods and materials for containment and for clean-up**. Take precautionary measures against static discharge.

8.6.5. Safe Handling and Storage

- **Safe handling:** Keep container tightly closed. Ground/bond container and receiving equipment. Take precautionary measures against static discharge. DO NOT get in eyes, on skin, or on clothing. DO NOT eat, drink or smoke when using this product. AVOID release to the environment. Wear protective gloves, protective clothing, eye protection, face protection.
- **Safe storage:** Store in a well-ventilated place and keep cool.
- **Additional information:** Eating, drinking and smoking in work areas is prohibited. Remove contaminated clothing and protective equipment, and wash hands after use and before entering eating areas.

8.6.6. Exposure controls and personal protection

- **Engineered controls:** No data available.

- **PPE:**

  - **Respiratory:** Use respiratory protection approved under appropriate government standards.
    - **Hand/Arm:** Handle with gloves approved under appropriate government standards.
    - **Eye/Face:** Face shield and safety glasses. Use equipment for eye protection tested and approved under appropriate government standards.
    - **Skin/Body:** Wear protective clothing
    - **Hygiene:** Handle in accordance with good hygiene and safety practice. Wash hands before and after handling.

    - **Special conditions posing a hazard**: Keep away from clothing. Ground/bond container and receiving equipment.

8.6.7. Stability and reactivity

Conditions to avoid: heat.

8.6.8. Disposal

- Refer to section 8.3.1 for the waste disposal restrictions, present and future.
- **Safe, environmentally preferred disposal:** Dispose of contents/container to an approved facility in accordance with all applicable regulations and landfill requirements per section 13 of the safety data sheet's relevant section.

- **Additional information:** Do not fly tip. Do not dispose into sewer, stormwater, or environment. Do not burn unless by means of compliant incineration practices.

9. CHEMICAL AND TECHNICAL SPECIFICATIONS – PRE-BENEFICIATION

Chemical analysis: Interpretation of results in terms of leachability potential, contamination of soils and the risks identified with the hazards of the waste for human health and the environment.

Refer to: For the full details of the analyses and assessments.

- Attachment 3a: Certificate of Analysis,
- Attachment 3b: Waste Assessment and Classification and
- Attachment 3c: Safety Data Sheet – SDS.

9.1. Introduction

Prior to being beneficiated, the sludge chemical and physical composition is represented in the laboratory analyses data (TC and LC). The basis of the leachability tests of the sludge was in anticipation of the disposal into the environment of the landfill site with putrescible waste and hence to low pH conditions. The leachability test was done with leaching liquid at pH 5. The pH of the sludge is 8.2, and will be subjected to pH conditions in its intended purpose of soil fertilizer under complex soil conditions. Farmers will manage the pH of the soils as required and as advised by an agronomist. Soils also have differing adsorption and absorption characteristics, hence the requirement for correct soil management for optimum use of the sludge:

- to have crops that are:
    - germinated to robust mature plants in good time,
    - robust with ideal sucrose levels,
- minimize environmental harm,
- minimize crop toxicity.

Research show that generally low pH conditions are conducive to easier leaching out of metallic components from their salts/mineral components.

Total concentrations for the sludge were determined as per NEM:WA - National norms and standards for the assessment of waste for landfill disposal. The data obtained represent the hazard risk to all stakeholders when exposed directly to the sludge. These exposures have been given toxicity or risk values. The GHS classification for the hazard of sludge is presented in table 2: Summary of sludge GHS hazard classification. Based on this, the sludge was given a hazardous classification for physical hazard. There was no data available for effect on human and environment health, based on the laboratory analyses.

The results for the Total Concentration (TC) and the Leachability Concentration (LC) are presented in Table 4: LC and TC laboratory results for the ISSM ETP sludge. These were used for the Framework for the Management of Contaminated Land database of the Guideline Soil Screening values. The Soil Screening Values (SSV) are the soil quality values, expressed as mass of contaminant per mass of soil, that are:

For SSV1: protective of **both human health and ecotoxicological risk for multi-exposure pathways, inclusive of contaminant migration to the water resource**. Soil Screening Values 1 are applicable to all land-uses, and thus represent an 'acceptable-risk' situation, with no adverse effects on human health and the aquatic environment.

For SSV2: that are **protective of risk to human health in the absence of a water resource.** Soil Screening Values 2 are land-use specific and have been calculated for three key land-uses namely, standard residential, informal residential settlements and commercial/industrial land-uses.

This approach was followed because ISSM has the intention of supplying the sludge to farmers for the use on their agricultural land as a fertilizer. This provides a valuable tool to assess the risks and the management of the activity and material to the land and the people that handle the sludge. It also provides an "acceptable risk" situation for human health and the aquatic environment in "all land-uses". It also presents risks to human health in the absence of a water resource for land specific use for three types of land uses:

- residential,
    - standard,
    - Informal.
- commercial/industrial.

The sludge will be:

- Dewatered on the ISSM site.
- loaded at the mill,
- transported to the farmer's site,
- offloaded,
- possibly stored,
- spread onto the land,
- immediately ploughed in.

so, information is needed on the potential risks to the people and to the environment to manage this material for safety.

9.2. Laboratory results

Date sampled: 17/10/2022.
Date received and testing commenced: 20/10/2022.
Report date: 15/11/2022

Table 4: LC and TC laboratory results for the ISSM ETP sludge.

Chemical	LC. (mgX/l)	TC. (mgX/kg)
Antimony	<0,05	<5
Arsenic	<0,08	<8
Barium	0,13	18
Boron	<0,16	<16
Cadmium	<0,17	<17
Chromium Cr^{+3}	<0,16	<16
Hexavalent Chromium	<0,0031	<0,031

Cobalt	<0,17	<17
Copper	<0,17	<17
Lead	**<0,08**	<8
Manganese	<0,17	124
Mercury	<0,0031	**4,6**
Molybdenum	<0,31	<31
Nickel	<0,18	<18
Selenium	**<0,63**	<63
Vanadium	<0,02	<2
Zinc	0,07	32

Chloride	5,44	-
Cyanide (Total)	0,03	<10
Flouride	0,31	3,1
Nitrate	<0,25	-
Sulphate	<2,5	-
TDS	617	-
CV	No CV	
Flashpoint at 22 C	No Flash	
FP at 60 C	**Flash**	
FP at 93 C	**Flash**	
pH (Aq Leach)@25	8.2	
Moisture %	**60**	
TOC	74%	
Sample description	Black sludge	
Odour	Damp odour	

Note:

- Bold highlighted analytical results exceed at least the lowest applicable concentration threshold per Appendix 1 of the T and T analytical report. for the assessment of waste to landfill.
- Where the laboratory detection limit for a test is higher than the required specification limit, the raw data is reviewed and the detection limit highlighted in bold font if outside of specification.

9.3. Total concentration and leachable concentration of components in sludge as a characterisation of the hazard nature of the sludge.

The sludge was determined to be a physical hazardous being a flammable liquid and vapour.

There was no data available to determine the risk to human and environment health as assessed by the GHS method. However, any potential hazards are managed and mitigated using the management measures as outlined in the Safety Data Sheet.

The waste is:

- CHEMICALLY assessed as low hazard -Type 3 waste when assessed for landfill.
- OVERALL waste assessment is very high risk - Type 0 waste, due to the prohibitions in place for high moisture content: 60% and for being a flammable liquid and vapour sludge mixture.
- The future restrictions for landfilling imposed would be because of the high TOC (74%) level
    - Subject to waste treatment and re-assessment per GN R634, the prohibition or restriction may be excluded.

There is thus a need to be aware of the effect of these components in the sludge on the receiving environment. The following are the sources of information for the possible effects that may be encountered to assess the risk of these components:

- Department of Environmental Affairs: Framework For the Management of Contaminated Land. May 2010.
- Department of Environmental Affairs, Government Notices.
    - R. 634: National Environmental Management: Waste Act (59/2008): Waste Classification and Management Regulations.
    - R. 635: National norms and standards for the assessment of waste for landfill disposal.
    - R. 636: National norms and standards for disposal of waste to landfill.

9.4. Soil Screening Values as a basis for developing risk assessment and risk management plans.

The remediation of contaminated land is being used as a base from which to determine the effects on the environment and related stakeholders.

This work is used to show the values used to assess the risk to the affected areas when the sludge is applied to the fields.
This approach will be a useful tool to manage the sludge and areas where it must not be used.

Table 5: Summary of the TC and LC values when compared to the soil screening values for protection of water resources. Metals only; shows the soil screening values required to achieve DWA Water Quality Guidelines levels for aquatic ecosystems protection and domestic water use. (Framework for the Management of Contaminated Land. 2010. p 33). The highlighted values are the guideline values that are exceeded by the TC values obtained. No LC values were exceeded.

Table 5: Summary of the TC and LC values when compared to the soil screening values for protection of water resources. Metals only. (Note, the highlighted numbers from these thresholds represent exceedances of the components in their total concentration and/or their leachable concentrations. NO leachable components were exceeded)

Parameter	SSV1	SSV2	SSV2	SSV2	Protection of water Resource	
	All Land-Uses Protective of the Water Resource (mg/kg)	**Informal Residential** (mg/kg)	**Standard Residential (mg/kg)**	**Commercial / Industrial (mg/kg)**	**Protection of Human Health (Drinking water usage) (mg/kg)**	**Protection of Ecosystem Health (mg/kg)**
Metals and metalloids						
Antimony	-	-	-	-		-
Arsenic	5,8	23	48	150	5,8.	580
Barium	-	-	-	-	-	-
Boron	-	-	-	-	-	-
Cadmium	7,5	15	32	260	7,5	37
Chromium Cr^{+3}	46000	46000	96000	790000	N/A	N/A
Hexavalent Chromium	6,5	6,5	13	40	19	260
Cobalt	300	300	630	5000	-	22000
Copper	16	1100	2300	19000	200	16
Lead	20	110	230	1900	20	100
Manganese	740	740	1500	12000	10000	36000
Mercury	**0.93**	**0,93**	**1**	**4,5**	**1**	**4,1**
Molybdenum	-	-	-	-	-	-
Nickel	91	620	1200	10000	91	1400
Selenium	-	-	-	-	-	-
Vanadium	150	150	320	2600	2000	-
Zinc	240	9200	19000	150000	3700	240

Anions	SSL

	(mg/kg)
Chlorides	12 000
Fluorides	30
Nitrate/Nitrite	120
Sulphates	4000

Note: Bold highlighted analytical results exceed at least the lowest applicable concentration threshold per for SSV guidelines. No leachate parameters were exceeded. The bold red font is exceedance of value from the TC analytical result. The other highlighted data is from the upper limit of the laboratory instrument detection limit, hence presents uncertainty in the value as representing a hazard.

Two tiers of Soil Screening Value have been defined as follows:

- **Soil Screening Value (SSV) 1** represents the lowest value calculated for each parameter from both the Human Health and Water Resource Protection pathways calculations as detailed under the preceding sections. SSV1 values are not land-use specific.
- **Soil Screening Value (SSV) 2** represents the land-use specific soil value calculated following the methods as detailed under the preceding sections. SSV2 values are land-use specific and are appropriate for screening level site assessment in cases where protection of water resource is not an applicable pathway for consideration.

The indication here is that the total concentration values presented some exceedances, but no leachable components were exceeded. Caution needs to be exercised in exposure of the material to all components in the SSV1 and 2 areas for concern:

- people in all residential areas,
- Industrial areas,
- water sources for all-land use,
- Protection of Human Health (Drinking water usage),
- as well as the ecosystem.

Using the assessments for human and environmental health in the GHS classification, there is no data available to determine human and environmental issues. However, using the SSV1 and 2 values and management tools, the hazard can be minimised outlined in the SDS. These are given in section 8.3 - 8.6 and will be used in the risk assessment and the risk management plan. It is also important that a qualified agronomist is used to guide the monitoring of the soil heatth and crop health.

9.5. Long term stability and functionality

The SDS indicated that there were no issues with the stability and reactivity of the sludge, if exposure to heat and sparks prevention was followed at all stages of the handling. Once the sludge is incorporated into the soils, the potential danger of fire is eliminated. The sludge is very moist and must be kept moist to prevent dust formation.

The sludge will thus have long term stability and hence its functionality will remain as a fertilizer, provided monitoring of soil and crops are maintained .

There is not data for incompatible materials for sludge however general care is needed when handling it. The condition to avoid is heat.

9.6. Reactivity with environmental factors

The following section gives an indication of the responses of the receptors to the concentrations of the exceeded components in the sludge in leachate. The system in total remains stable under natural environmental conditions.

9.7. Leaching potential showing long term stability and functionality, reactivity with environmental factors.

The leachability testing is done as per requirement for waste management at a landfill site. The sample was subjected to an Australian Standard Leaching Procedure (ASLP2 Acetate pH 5.0 (P/NP)) as per National Environmental Management Waste Act 59 2008, for the National norms and Standard for the assessment for waste for landfill disposal. The resultant leachate was analysed for various components. However, the requirement is for the sludge to be used as a fertilizer in agricultural soils. The pH of the sludge is 8.2. The optimum pH of fertilizers applied to the fields would be determined by the suitably qualified and experienced agronomist. It would need to be adjusted to suit the needs of the crop. The slightly higher pH values would reduce the leachability of the heavy metals into the environment. It is also uncertain the adsorption and absorption of the metals would be onto the soil particles over time of the applied sludge. However, this would be factored into the soil monitoring of the fields over time. The various components in the sludge would need to be monitored including the total dissolve solids (TDS) to ensure that the soil retains its integrity over time. This would be the function of the agronomist.

The practical implications of the leachability test in the laboratory would be a conservative approach to what may be presented to the environment. This is not the case in the fields. The soils would at best be kept moist and not wet. This would prevent the heavy metals from migration especially to the water sources, and to the outside environment through water borne means. Lead and selenium showed leachate exceedances for landfill assessment, with mercury TC exceedance.

The leachable components from the leachability testing were not exceeded in the SSV1 and SSV2 test thresholds. There was total concentration exceedance for arsenic, Cadmium, copper, and mercury. However, all these components except the lead were measured because of the detection limit of the laboratory instruments. Only mercury was measured and an exceedance in the landfill assessment. This implies that the sludge would need management to reduce any potential impacts in the SSV1 and SSV2 parameters based on the TC of the sludge when it is applied to the soil.. The GHS assessment did not present any data to indicate specific concerns. The waste is deemed low risk.

10. CHEMICAL AND TECHNICAL SPECIFICATIONS – POST-BENEFICIATION

Once the sludge has been applied to the soil, it is anticipated that it will be assimilated into the soil through natural biological processes to produce good crops. This implies a sludge dilution effect. The effect on the environment will be minimised due to this and also because of the management of the sludge to not impact human or environmental health. The sludge is a low risk waste stream to be used in agricultural fields. The application onto the fields including repeat applications must be done under the supervision of an agronomist.

10.1. Intended users of the waste stream

The intended use of the waste sludge is for the purpose of soil enrichment. The recipients of these waste streams are farmers. The fields for application would need be away from any human residences and the correct management would be in place to prevent any run-off into natural water courses. The users would be utilising the services of a qualified agronomist

10.2. Long term stability and functionality

The sludge remains stable throughout their useful life.

10.3. Reactivity with environmental factors

No adverse reactivity nor instability were noted in the SDS report. Caution is noted for the exceedances given in the SSV chart. However, when applied to the fields and ploughed into the soil, this would be a diluting effect from the sludge being dispersed into the soils.

The consideration must be made for sludge brought into the fields and stored. If the sludge is allowed to be in the fields untouched for a long time, then it can dry out, increasing the fibres exposure to the fermentation temperatures and start to smoulder. This presents a fire risk in the sugar cane fields, or wherever the sludge is stored. Included in the risks would be a potential plume of leachate based heavy metals into the ground contaminating the ground water and environment. Hence no excess sludge piles should be stored in the fields which is not ploughed into the soils and dispersed well.

Should repeat applications be made onto the fields, the monitoring by the agronomist of the soil conditions should ensure an environment in the soils which is not hazardous to crops, water sources through leaching and to the surrounding environment.

11. IDENTIFICATION OF POTENTIAL RISKS AND MANAGEMENT THEREOF

Refer to: Attachment 4: Risk assessment ISSM ETP sludge and Attachment 5**:** Risk management plan ISSM ETP sludge.

12. REFERENCES

1. *https://www.illovosugarafrica.com/about-us/south-africa.*
2. Dotaniya ML, Datta SC, Biswas DR, Dotaniya CK, Meena BL, Rajendiran S, et al. *Use of sugarcane industrial by-products for improving sugarcane productivity and soil health.*

*I*nternational Journal of Recycling of Organic Waste in Agriculture. 2016;5(3):185–94. (https://link.springer.com/article/10.1007/s40093-016-0132-8).

13. DECLARATION BY SPECIALIST – ANNE BINDOFF

All information and instructions provided in this report in respect of the Risk Assessment and Risk Mitigations/Management Plan substance is given in terms of the provisions of the National Environmental Management: Waste Act (59/2008): Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste.

Information and data is based on available information given by Illovo Sezela Sugar Mill and is the best information available through general research based on this information as at the date of this report. It is presented in good faith, to be correct.

Name: Anne Bindoff

Signature: ..... **Date:** 17th September 2023.....

Address: PO Box 1794,
Umhlanga Rocks, 4320.

Cell: (083) 655-1132
Mail: annebc@cykelbin.co.za.
Web: www.etremkards.co.za.